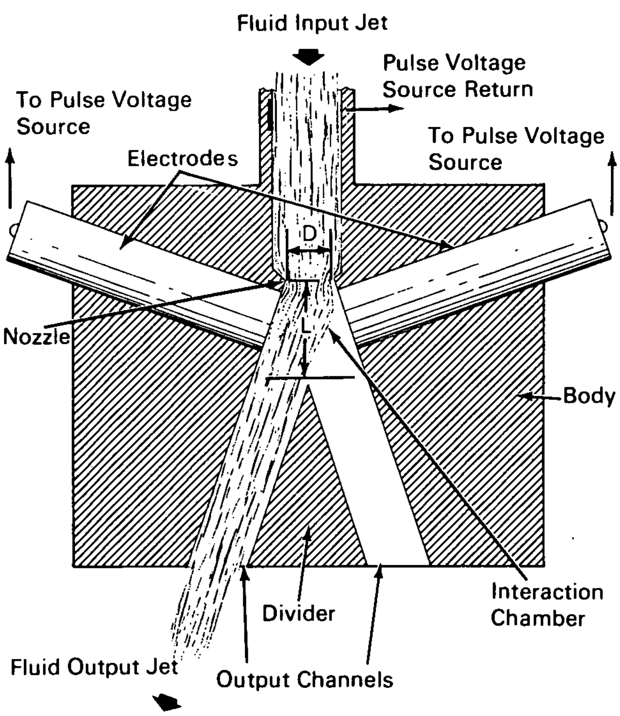
NASA TECH BRIEF

Bistable Fluidic Valve Is Electrically Switched

The problem:

In fluidic systems (systems without moving parts other than the operating fluid itself), switching of a fluid jet from one flow channel to another is effected by a control jet of the operating fluid. In certain applications it is desirable to use electrical signals,



rather than a control jet, to initiate the switching of the fluid jet. However, conventional electrical switching arrangements have required relatively intricate valve designs and precision components. The complexity and high cost of such hybrid systems have limited their use.

The solution:

A bistable control valve that can be selectively switched by direct application of an electrical field, rather than a control jet, to divert the fluid from one output channel to another. The valve is inexpensive, does not have any moving parts, and operates on fluids that are relatively poor electrical conductors.

How it's done:

As shown in the cross-sectional view, the body of the valve includes an input channel which terminates in a nozzle (diameter D) at the entrance of the interaction chamber (minimum length L). Two diverging output channels separated by a divider, extend downstream from the interaction chamber. Two electrodes, connected to a variable dc voltage source, are mounted in the valve body on each side of the interaction chamber, with the end faces of the electrodes parallel to the side walls of the chamber.

In operation of the valve, the fluid input jet will initially be deflected by the apex of the divider into one of the two output channels. In either of these channels (e.g., the left channel), the fluid jet is in a stable condition and follows the channel wall as a consequence of the Coanda effect. Assuming that the jet is locked to the left wall of the left channel, the jet can be switched to the right output channel by applying a prescribed voltage pulse to the right electrode. Stable flow will then continue in the right channel until a voltage pulse is applied to the left electrode, at which time the flow will be switched back to the left channel. The jet can be switched from channel to channel as required by applying a voltage pulse to the appropriate electrode. The voltage pulse is only required during the switching operation, and the jet is deflected as a cylindrical body (conforming to the channel), not as droplets; it

(continued overleaf)

will remain attached to the wall of either channel by the Coanda effect.

The force exerted on the fluid jet by the applied electric field depends on the dielectric constant of the fluid, the charge density, the length of the jet (L) acted upon by the applied field, the diameter (D) of the jet, and the fluid density. The ratio L/D determines the position of the electrodes with respect to the output jets and optimum electrode geometry.

Notes:

1. Satisfactory operation was obtained with an experimental valve made of acrylic resin and using copper electrodes which were independently connected to a 30 kV dc voltage source; water at a moderate flow rate was supplied to the inlet channel from a plenum pressurized with nitrogen gas.
2. Valves having a larger number of stable conditions and outputs can be designed in accordance with the principle of the bistable valve.
3. Valves of this type are capable of performing logic control functions without the use of mechanical parts. They are readily adaptable to electronic system control and readout devices.
4. The valves must be operated at voltages below a critical value to prevent unstable flow oscillations and arcing which may be destructive.
5. Requests for further information may be directed to:

   Technology Utilization Officer
   NASA Pasadena Office
   4800 Oak Grove Drive
   Pasadena, California 91103
   Reference: TSP70-10517

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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